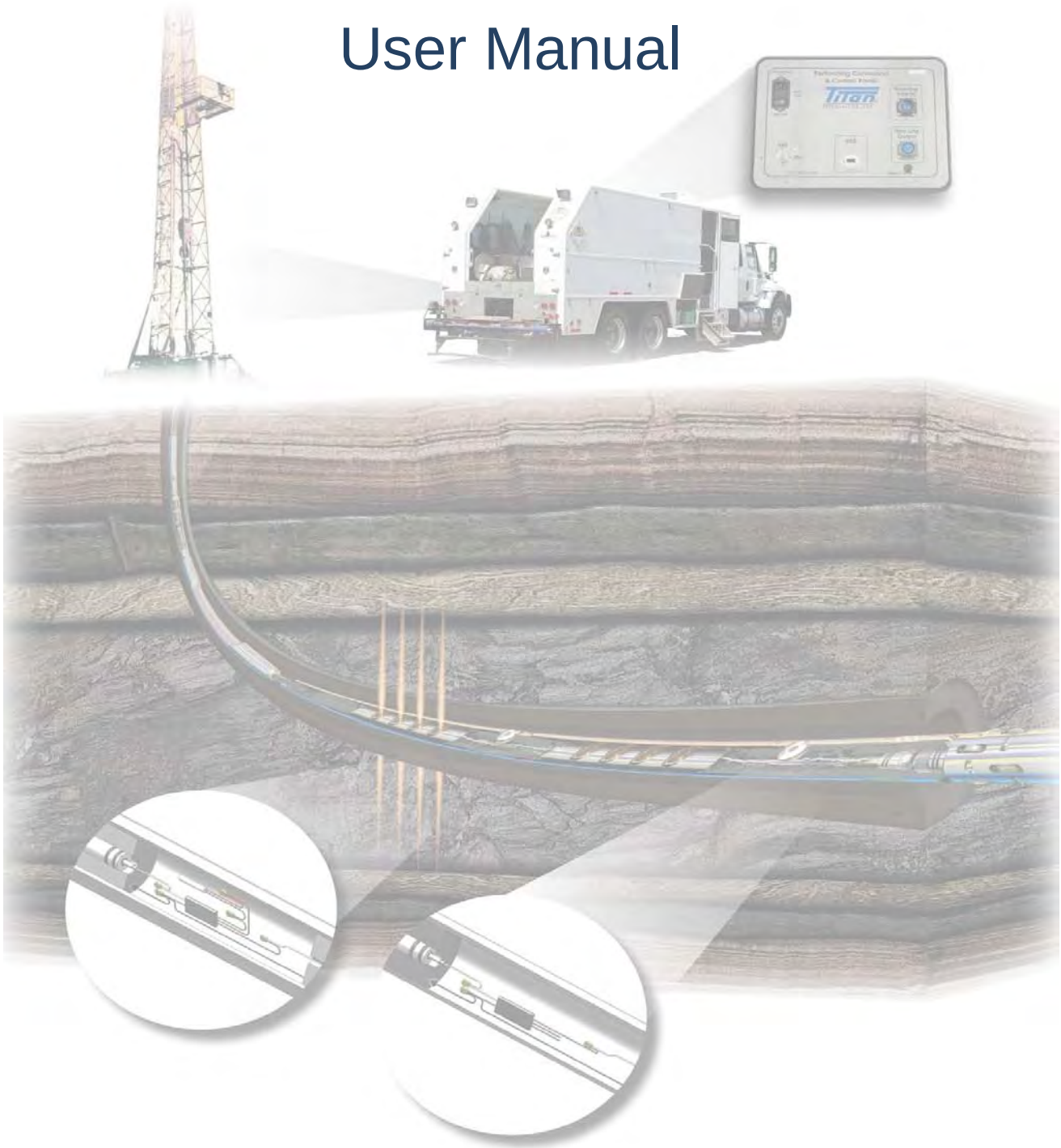
ControlFire®

User Manual



Rev AH February 2012

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Safety Precautions When Using ControlFire® Perf Unit

The following precautions must be followed when using the ControlFire® Perf Unit.

1. Do NOT open the unit and try and service. If any service or repair is required the unit must be returned to the manufacturer, Hunting Titan.
2. Always use the recommended AC power cord that includes a 3rd wire safety ground that connects equipment to a grounded single phase outlet.
3. When installing into a wireline truck always position the ControlFire® Perf Unit so that the AC cord can be accessible for rapid disconnect.
4. When replacing either the AC fuse or W/L fuse always use the exact replacement P/N.
5. If equipment is not used in a manner specified by the manufacturer, safety protection may become impaired

Safety Symbol Explanation

Caution: Risk of danger, refer to user guide.

Warning: Electrical shock hazard.

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1.0 Equipment Overview

The minimum equipment required for running a ControlFire® switch system is listed.

Item	Equipment Description	Titan P/N
1	ControlFire® Command & Control Panel	9002-013-510
2	Cable Kit	9002-013-017
[1]3	Wireline Switch Simulator Panel	9002-013-610
4	ControlFire® Perforating Switch Rev 1.8 PCB 1.0D	9002-013-120-1.8
[1]5	Wireline Switch Simulator Panel External Test Block	9002-013-320

[1]Items 3 and 5 can be used for system verification at the shop or on a job location

- **ControlFire® Perforating Command and Control Panel** – Shown in Figure 1 is a surface control panel that provides communication and control to the downhole ControlFire® switch string. This control panel interfaces with a PC or Laptop via a "USB connector", connects to a Shooting Power Supply through the "Shooting PWR In" connector and to a wireline cable via the "Wire Line Output" connector. The Perforating Command and Control Panel is available as a portable panel, rack mount panel or integrated into a shooting power supply as a combination rack mount panel. See Section 10 for part numbers.

Figure 1

- **Cable Kit** – Shown in Figure 2 are the normally required cables and connectors. An itemized listing is given:

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Figure 2

1. AC Input Power Cord – Three wire power cord for connecting the Control Panel to an AC power source (hot, natural and safety ground). The safety ground (3rd wire) within the AC receptacle must be connected to earth ground.
   Ground wire must be Green/Yellow.
   Cord should be:
   3-Conductor, 18AWG, 10A, 60ºC minimum, 3m length maximum
2. Shooting PWR In Cable - RG8 Coaxial Cable, 10 feet long, with Cannon Female Plug and Male UHF PL-259 connectors
3. Wire Line Output Cable - RG8 Coaxial Cable, 10 feet long, with Cannon Male Plug and Male UHF PL-259 connectors
4. Double Female UHF adaptor – Used to convert the Male UHF of the Wire cable to a female gender
5. USB cable – Male to Male cable used to interface a PC or Laptop to the Control Panel
6. Line Output Test Cable and (1) UHF Female to double banana pin connector to plug into the WL Switch Simulator

- **Perf Switch and Wireline Simulator Panel** – Shown in Figure 3 is a Perf Switch Simulator that allows the user to perform demonstration, training exercises, and troubleshoot/verify wireline interconnections at the well site.

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Figure 3

- **Wireline Switch Simulator Panel External Test Block** – Shown in Figure 4 is a connector block with a cable that plugs into the Perf Switch Simulator, Deto I/O interface. This assembly provides the user a means to connect resistors to each of the 6 Perf Switches inside of the Perf Switch Simulator for the purpose of simulating a detonator firing. This concept can be used for demonstration, training and troubleshooting wireline problems on a job site.

  DO NOT CONNECT LIVE DETONATORS!

Figure 4

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- **ControlFire® Switch Rev 1.7 PCB 1.0D** – Shown in Figure 5 is an expendable ControlFire® Perf Switch. Every gun/plug in a gun string must be equipped with a Perf Switch. Each switch can be verified, armed, selectively fired or skipped upon command from the surface. An RF-Safe ControlFire® system is also available. See Section 10 for part numbers regarding the RF-Safe ControlFire® assembly options.
  (Note: ControlFire® switch body may be black shrink wrap or maroon plastic)

Figure 5

2.0 ControlFire® Perforating Panel and Switch Specifications

Table 1 gives the specifications for the ControlFire® Perforating Command and Control Panel. Table 2 shows the specifications for the ControlFire® switch.

Specification	Rating/Description	Conditions
Temperature	(-10 to +55)C (+14 to +131)F	Operating
	(-10 to +55)C (+14 to +131)F	Start Up
	(-30 to +75)C (-22 to +167)F	Storage
Humidity, RH%, Operating & Storage	10 to 95% RH	Non-Condensing
Altitude	0 – 10,000ft	Operating
	0 - 45,000ft	Storage
IEC60529 Rating	IP67 (1 meter submersion for 30 minutes)	
AC Input Voltage	120-220 VAC	0~100% load
Frequency, Range	50 – 60 Hz	0~100% load
Input Power	150W Max	
AC Power Cord	3 conductor,18AWG, 10A, 60ºC minimum, 3m length maximum	Operating
AC Entry Fuse	250V, 1.6A, 5mm X 20mm slow blow. Part# BK/GDC-1.6A	Operating
Wire Line Fuse	250V, 0.63A, 5mm X 20mm Slow blow. Part# BK/GDC-630MA	Operating

Table 1

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ControlFire® Switch Specifications

ENVIRONMENTAL	
Operating Temperature Range	-20 °F (-29 °C) to 347 °F (175 °C)
Survival Temperature	-58 °F (-50 °C) to 392 °F (200 °C)
Max Thermal Change	42.8 °F (5 °C) / Minute
Vibration Compliant	Compliant to all hollow carrier gun systems
Vibration (3 axis)	50 g RMS @ Sweep Frequency 50-1000 Hz
ELECTRICAL	
Operating Voltage Range	-5 VDC to -550 VDC
Operating Current – Standby	>1mA
Current – Communicating	10mA at Surface 30mA Downhole
Bi-directional Communications	Bi-directional
COMPATABILITY	
Detonators – Hot Wire	50 ohms or higher (single or double resistor types)
Igniters – Setting Tools	50 ohms or higher
RF Safe Detonators	PX-1/EBW, RED (all versions)

Table 2

3.0 Installing Software for ControlFire® Perforating Panel

The following procedure will provide a step-by-step guide for installing the ControlFire Perf Unit GUI and USB Virtual Com Port Driver onto a PC or laptop.

3.1 Installing GUI Program

Installation Steps:

1. Any previous versions of Titan Perf Unit must be uninstalled before attempting to install a newer version of the Titan Perf Unit 4 program. Use the Add/Remove program on the control panel and remove any previous existing version of Titan Perf Unit 4.
2. Download TitanPU4_Setup_7_18_11.zip file into the folder of your choice.
3. Unzip files. A sub-folder , TitanPU4_Setup_7_18_11 will be created. Go to this folder.
4. Double click on setup.exe as seen below in Figure 6.
5. If Microsoft .NET Framework 4 is not installed on PC/Laptop then a popup will appear asking to install. Allow the installation.
6. When the “Welcome to the Titan Perf Unit 4 Setup Wizard” appears, click Next.

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setup.exe
Setup
SetupPU4.msi
Windows Installer Package
4,903 KB
Titan Perf Unit 4
Welcome to the Titan Perf Unit 4 Setup Wizard
The installer will guide you through the steps required to install Titan Perf Unit 4 on your computer.
WARNING: This computer program is protected by copyright law and international treaties. Unauthorized duplication or distribution of this program, or any portion of it, may result in severe civil or criminal penalties, and will be prosecuted to the maximum extent possible under the law.
Cancel
< Back
Next >

Figure 6

7. The License Agreement then appears, as shown below in Figure 7. Read through the agreement and if you agree, Click the “I Agree” radio button. (Otherwise if you do not agree, click cancel) Then click next.

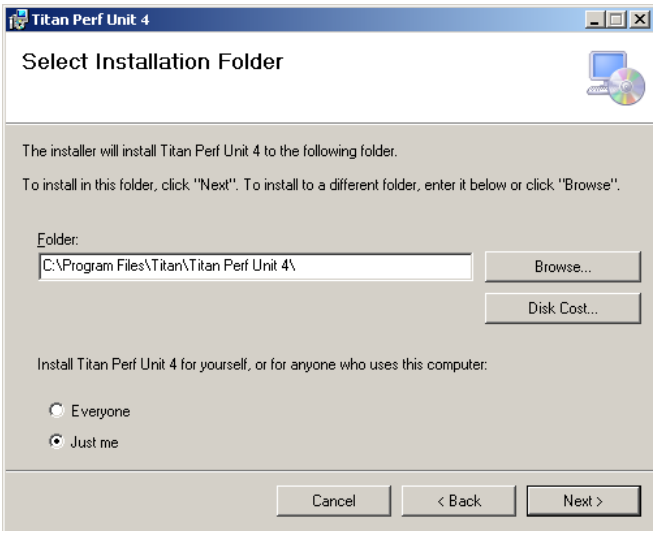
Titan Perf Unit 4
Select Installation Folder
The installer will install Titan Perf Unit 4 to the following folder.
To install in this folder, click "Next". To install to a different folder, enter it below or click "Browse".
Folder:
C:\Program Files\Titan\Titan Perf Unit 4\
Browse...
Disk Cost...
Install Titan Perf Unit 4 for yourself, or for anyone who uses this computer:
Everyone
Just me
Cancel
< Back
Next >

Figure 7

8. The Select Installation Folder then appears next. Choose a Folder of your choice or use the default Folder. Click next

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9. The Confirm Installation Screen appears. Click Next as shown in Figure 8.

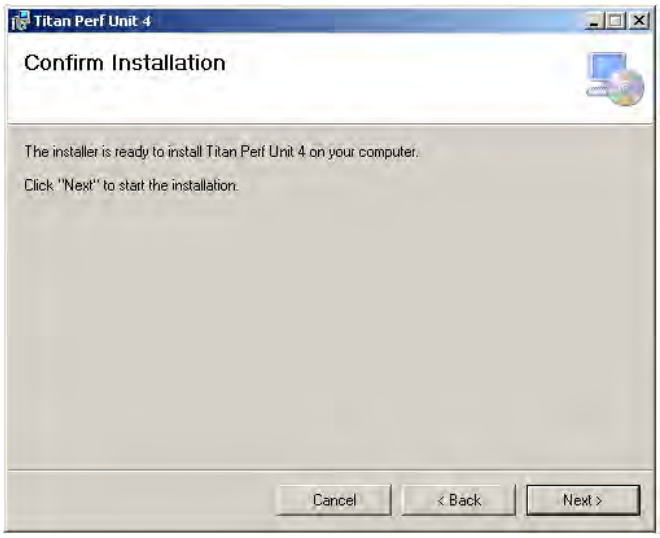
Titan Perf Unit 4
Confirm Installation
The installer is ready to install Titan Perf Unit 4 on your computer.
Click "Next" to start the installation.
Cancel
< Back
Next >

Figure 8

10. The Installing Titan Perf Unit 4 screen appears, shown in Figure 9, and the program installs along with showing a progress window to completion.

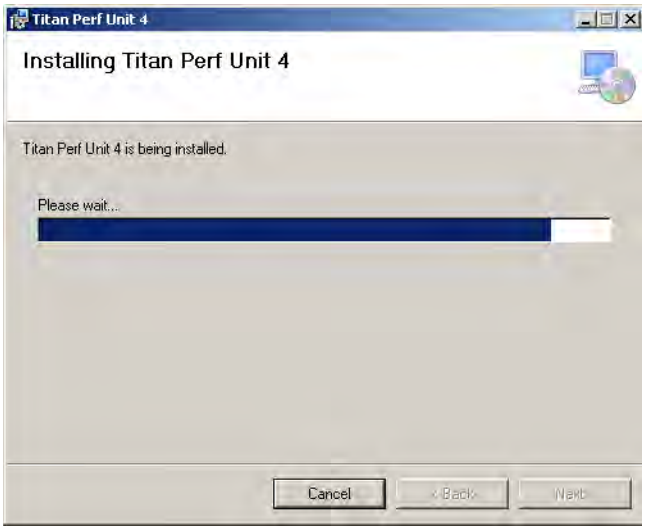

Figure 9

11. The Installation Complete window appears, shown in Figure 10, indicating a successful install. Closing the window completes the installation.

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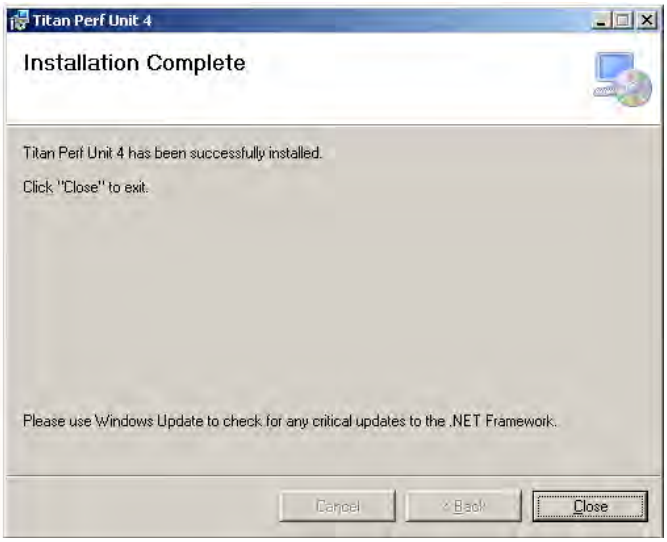
Titan Perf Unit 4
Installation Complete
Titan Perf Unit 4 has been successfully installed.
Click "Close" to exit.
Please use Windows Update to check for any critical updates to the .NET Framework.
Cancel
< Back
Close

Figure 10

12. A Titan PU4 USB icon appears on desktop. See image in Figure 11. Double clicking on icon initiates the Perf Unit 4 program.

Figure 11

3.2 Installing USB Virtual Com Port Driver

As a result of a successful install in section 2.0 an executable VCP driver file was also copied onto the hard drive but not installed. If the default install location were chosen the driver file would be located at: C:/Program Files/Titan/Titan Perf Unit 4/CDM20814_Setup.exe. (For Windows 7 and 64 bit machines the root would be Program Files(x86) The driver is supplied by FTDI and can also be found at: http://www.ftdichip.com/Drivers/VCP.htm This driver support includes the following versions of the Windows operating system: Windows XP, Windows Server 2003, Windows Vista, Windows Server 2008, Windows 7, Windows Server 2008 R2. Processor Architecture includes x86 (32-bit) and x64 (64-bit)

To install the new VCP driver double click on CDM20814_Setup.exe. The file is a setup executable will automatically install.

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4.0 Installing ControlFire® Perforating Panel on Logging Truck

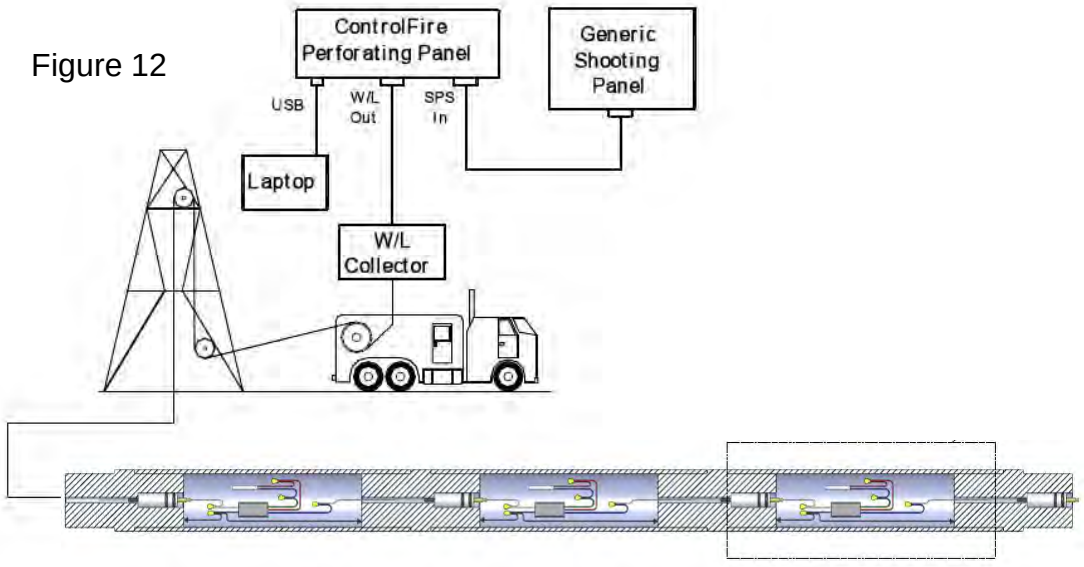
The ControlFire® Perforating Panel would be typically installed in a logging truck as shown in Figure 12. Cabling would be installed in the order listed below:

1. Shooting PWR In Cable, RG8 Coaxial Cable with Cannon Female Plug and Male UHF PL-259 connectors:
    a. Connect the Male PL-259 connector to Shooting Power Supply output.
    b. Connect Cannon connector to the Perf Panel, Shooting PWR In.
2. Wire Line Output Cable - RG8 Coaxial Cable with Cannon Male Plug and Male UHF PL-259 connectors:
    a. Connect Cannon connector to the Perf Panel, Wire Line Output.
    b. Install the Double Female UHF adaptor on the end of the PL-259 male connector.
    c. Connect the UHF end of the cable to the truck Wire Line Collector.
3. USB cable:
    a. Connect one end of cable to a USB input of a PC or Laptop to the Control Panel.
    b. Connect the other end of the USB cable the USB input of the Perf Panel.
4. AC Input Power Cord:
    a. Turn both the Power Entry switch and the Safety Key switch to OFF before installing the AC Power Cord.
    b. Connect the female receptacle to the Perf Panel 120/220 Power Entry connector.
    c. Plug the AC cord into an AC receptacle of the logging truck.

The Perf Panel is now ready for service. Turn the Power Entry switch to ON and the Safety Key switch to ON. The red light on the Perf Panel should turn on.

Safety: Position ControlFire Panel in truck such that power can be easily disconnected.

Figure 12



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5.0 ControlFire® Operation

The following operation procedures for the ControlFire® are described:

1. Starting the ControlFire® Software
2. Perf Unit Setup for ControlFire® Operations
3. Perf Unit Setup for ControlFire® Operations

5.1 Starting the ControlFire® Software

The follow steps are required to start the Titan GUI software

1. Double click the Titan ControlFire® PU4 icon on your desktop. See Figure 13.

Figure 13

The License Agreement screen appears as shown in Figure 14

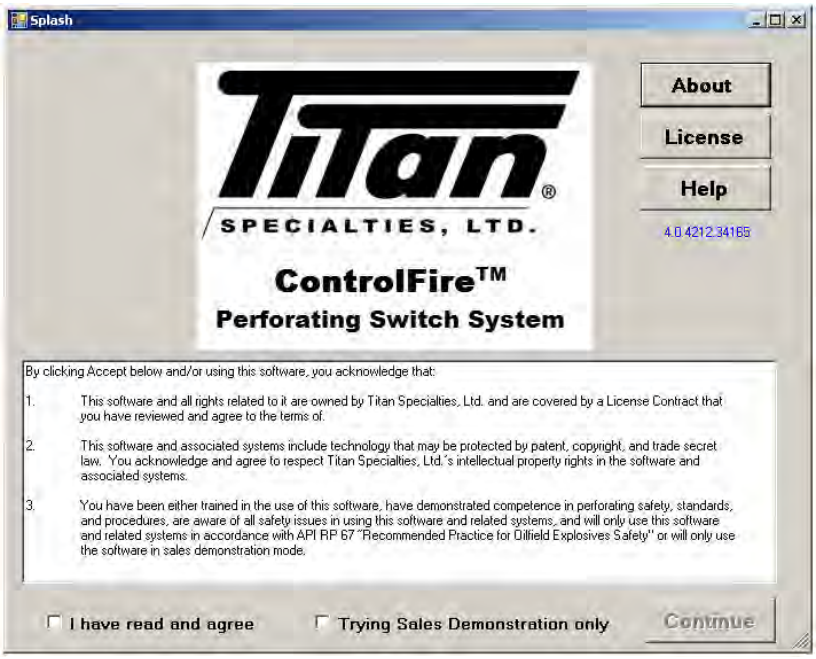
Splash
About
License
Help
4.0.4212.34169
SPECIALTIES, LTD.
ControlFire™
Perforating Switch System
By clicking Accept below and/or using this software, you acknowledge that:
1. This software and all rights related to it are owned by Titan Specialties, Ltd. and are covered by a License Contract that you have reviewed and agree to the terms of.
2. This software and associated systems include technology that may be protected by patent, copyright, and trade secret law. You acknowledge and agree to respect Titan Specialties, Ltd.'s intellectual property rights in the software and associated systems.
3. You have been either trained in the use of this software, have demonstrated competence in perforating safety, standards, and procedures, are aware of all safety issues in using this software and related systems, and will only use this software and related systems in accordance with API RP 67 "Recommended Practice for Oilfield Explosives Safety" or will only use the software in sales demonstration mode.
I have read and agree
Trying Sales Demonstration only
Continue

Figure 14

2. Review the About, License, and Help tabs on the ControlFire® Perforating Switch System page and check the **I have read and agree** box and then click **Continue.** The Select Perf Unit ComPort screen will appear after selecting the **Continue** button as shown in Figure 15.

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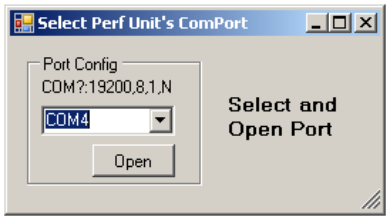

Figure 15

3. Select the appropriate Com port for communication to the Perforating Command and Control Panel and then click **Open**. When reusing the same computer and Perf Unit the Select Perf Unit Com Port screen may not appear and instead the Set-Up screen appears as shown in Figure 16.

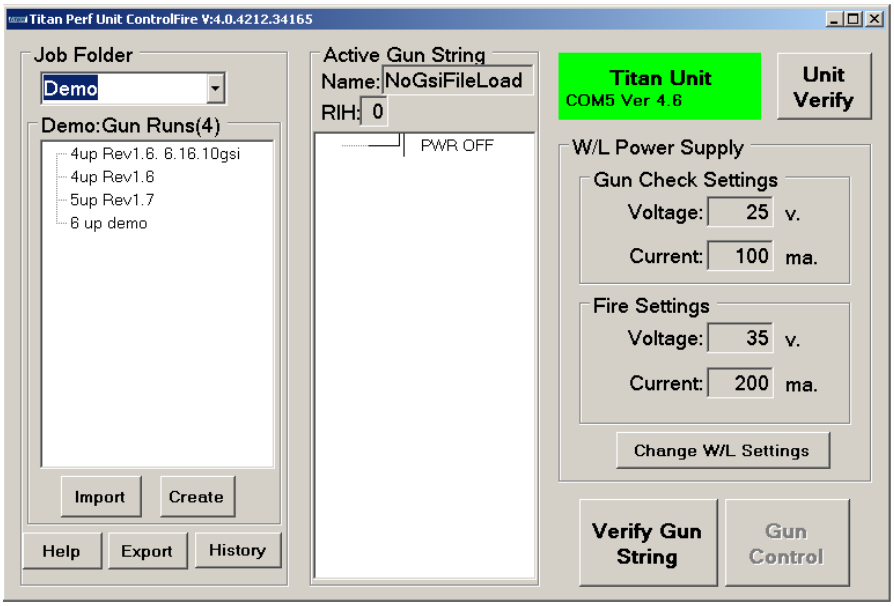

Figure 16

4. The Titan ControlFire® software has now started and the user interface is available with the Perf Unit Set Up screen visible.

Perf Unit Setup Screen Definitions:

Job Folder – A dropdown is used to either create a new job folder, or use an existing job folder.

Import – Activates a previously saved gun string file from another file location.

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Create – Generates a new gun string associated with the selected Job Folder.

Help – When selected, a ControlFire® Users Manual is opened for viewing.

Export - Exports the job history for a specified job.

History – Opens a screen to view the history of each run within the job folder. It also enables the user to export specific V/I plots within the job folder.

Unit Verify – Confirms communication with the Perforating Command and Control Panel. The Titan Unit box will be displayed in green if communication is enabled and yellow if communication is not established.

Change W/L Settings – Enables the user to input specific information about the collar locator, wireline cable properties, well conditions, and number of switches run into the well in order to calculate the panel voltage requirement when **Calculate Voltage Settings** and **Save W/L Settings** buttons are selected.

Verify String – Establishes communication with the gun string and confirms that the gun string created in the software physically matches the actual gun string to be run into the well. Once confirmed the Gun Control button will become enabled.

Gun Control – Changes focus from the job setup screen to the perforating operation interface.

5.2 Setup for ControlFire® Operations

5.2.1 Create New Job Folder

A new Job Folder in normally created for a client on every new job. Refer to Figure 17 for the next steps:

1. Highlight the existing name in the Job Folder window and then type in the new name and press the Enter key on keyboard (For example only, use **Titan Job 1**).
2. Select **Yes** in response to Add new job folder on"Job Folder Not Found" pop up. This will create a new job folder, **Titan Job 1**, located in directory: **C:\TitanData\Titan Job 1**.

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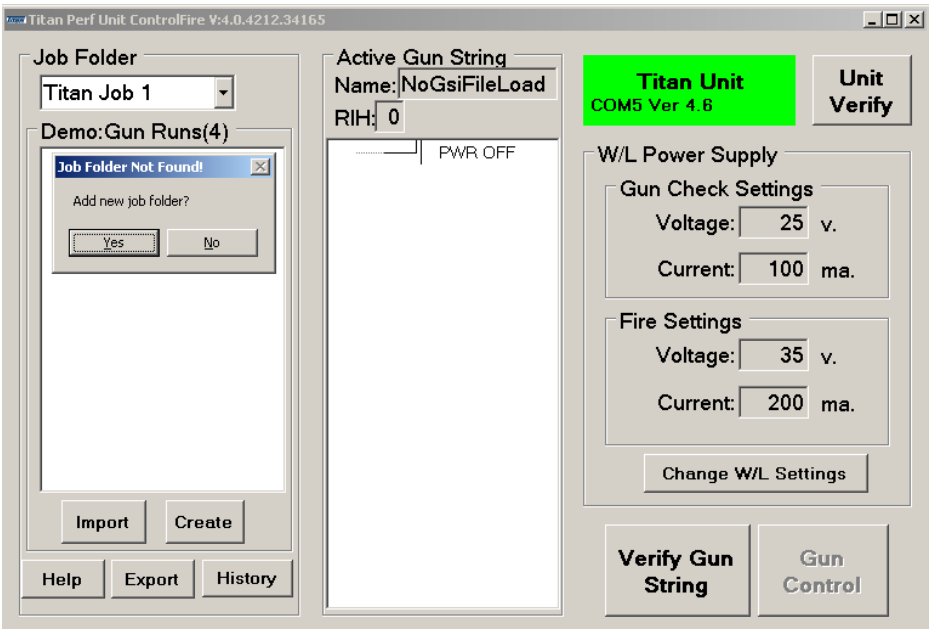

Figure 17

5.2.2 Change W/L Settings

Changes in W/L Voltages and Currents settings are required because of variances in wireline resistance due to length and type, as well as temperature, CCL characteristics and type of detonator.

From the setup screen in Figure 17, select the **Change W/L Settings**. This brings up the W/L Information screen shown in Figure 18.

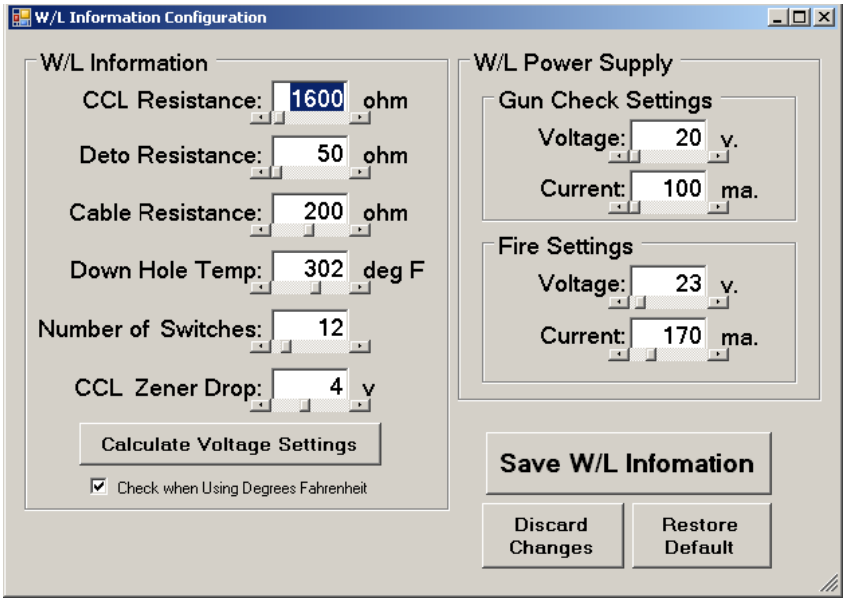

Figure 18

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Input the following parameters: CCL Resistance, Detonator Resistance , Cable Resistance, Downhole Temperatue and number of switches in string.

Select **Calculate Voltage Settings** - This caclulates and inserts new Voltage and Current values in the the **Gun Check Setting** and **Fire Setting**.

Select the **Save W/L Information** - New voltage current values are saved in the current job folder.

5.2.3 Create a New Gun String

Perform the following steps to create a new gun string for a specific job folder. (For this example the Titan Job 1 folder will be used) At this point the user must have the Perforating Command and Control Panel connected to the gun string in order to communicate with the Perf Switches and create a gun string file.

1. Select Titan Job 1 folder (Refer to Figure 17)
2. Click on the **Create** button to create a new gun string. This opens the Create Gun String Screen shown in Figure 19

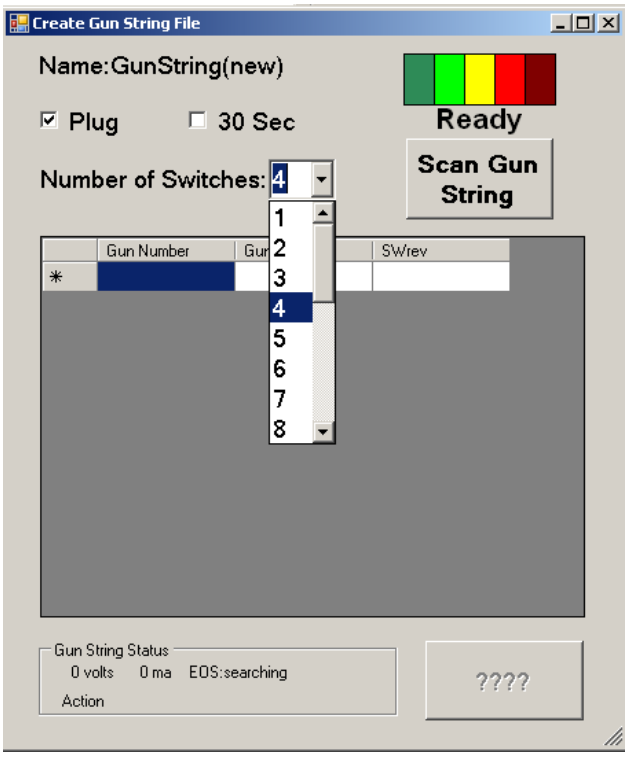

Figure 19

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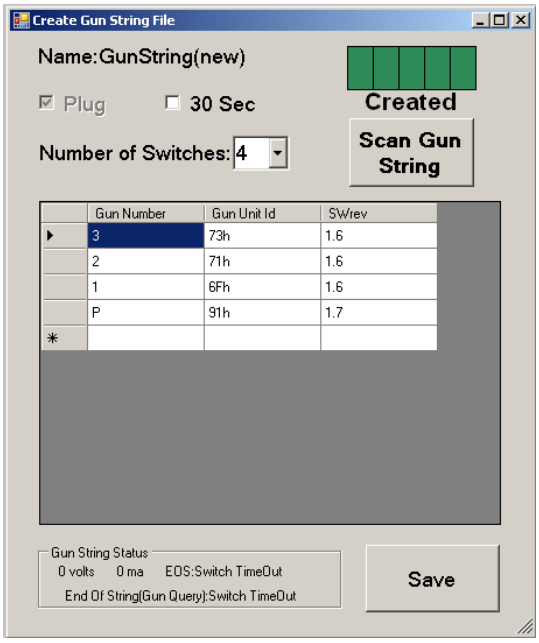

Figure 20

3. Use the **Number of Switches** dropdown to select the number of switches in the string.
4. Check the **Plug** box if the string includes an igniter for setting a plug. The plug can now be powered by the Shooting Power Supply for 30 seconds
5. There are some cases when a 30 second shooting is required for all guns. If this is the case then also check the **30 Sec** box.
6. Select the **Scan Gun String** button, this action will power the wireline and send a sequence of commands from the Perforating Command and Control Panel to the Perf Switches and confirm a functional string. See Figure 20.
7. Switch Unit IDs will be displayed along with the switch revision number in the Create Gun String File window. The number of Perf Switches found must match the number of switches selected. If not, a String Count Mismatch popup occurs and the Scan Gun String must be repeated before the gun string file (file.gsi) can be saved.
8. Once the user input and the physical gun string match, select the **Save** button and create the new gun string file. As an example, shown in Figure 21, a Titan Run 1.gsi file was created.

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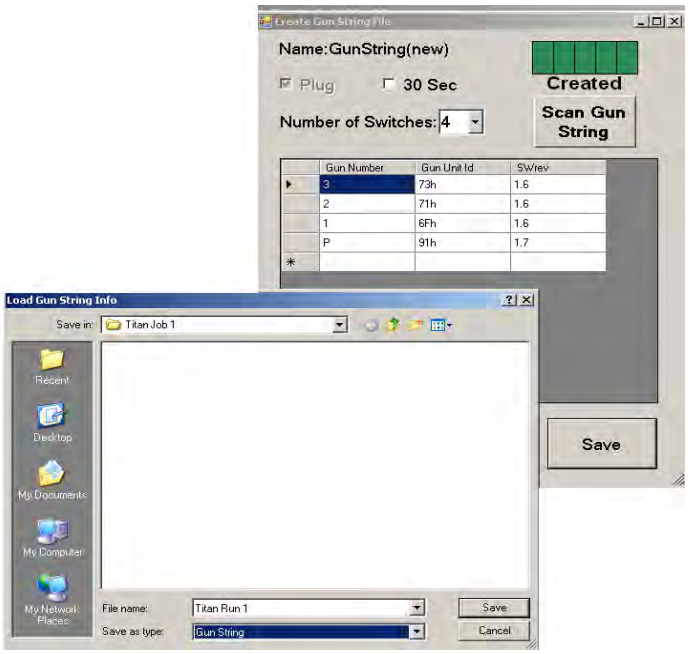

Figure 21

5.2.4 Verify Gun String

After a Gun String File has been successfully created, it requires to Verify Gun String. The screen in Figure 22 is use for the process.

1. Select the **Verify Gun String** button on the Set Up Screen. The Verify Gun String screen appears and the gun string is validated against the Titan Run 1.gsi file. Following a successful scan the Verified box turns green.
2. Select the **Use** button on the Verify Gun String screen. This action activates the **Gun Control** button on the Set Up screen.

Figure 22

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This completes the setup process and a given gun string ready. The Gun Control screen is now ready for use.

5.3 Gun Check, Arming and Firing

Following a successful Verify, the gun string is ready to begin a Gun Check, Arming and Firing sequence. To start these sequences, select the Gun Control button on the Set Up screen in Figure 22. This activates the Gun Control Screen in Figure 23.

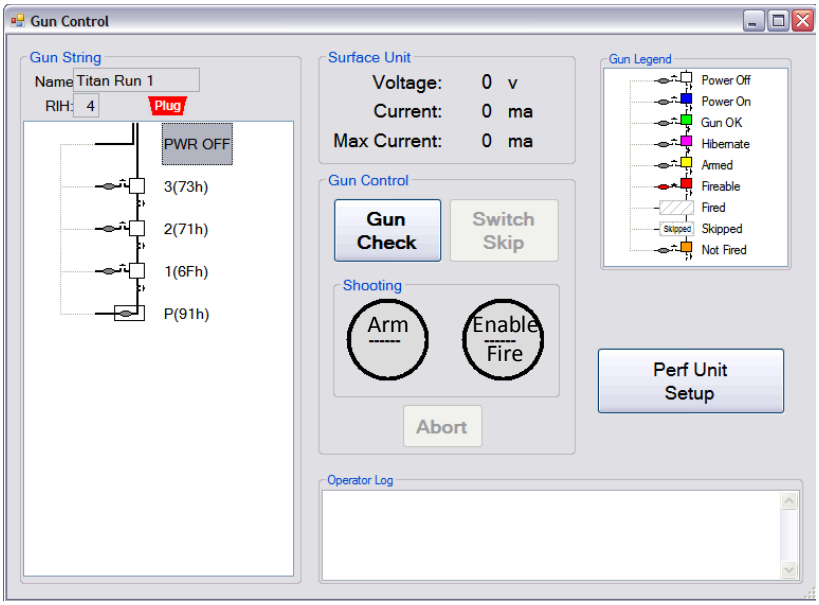

Figure 23

Gun Control Window Definitions:

Warning: All Gun Control commands must be performed in a wellbore at a depth of greater than 200 feet or according to the operator's standards.

Gun Check –The **Gun Check** button requests the Perforating Command and Control Panel to send a set of commands to the Perf Switches and read the status of all the switches in the string. An unlimited number of Gun Check requests can be performed on the gun string. Once the Gun Check is successfully completed, the **Arm** button is accessible to the user.

Arm – Selecting the **Arm** button sends a ARM command to the bottom most active switch. Once the selected gun is armed, the **Enable Fire** button is accessible to the user for 15 seconds. If an enable fire is not sent within a 15 second time window, the Perforating Command and Control Panel will revert back to a pre-initialized gun check screen.

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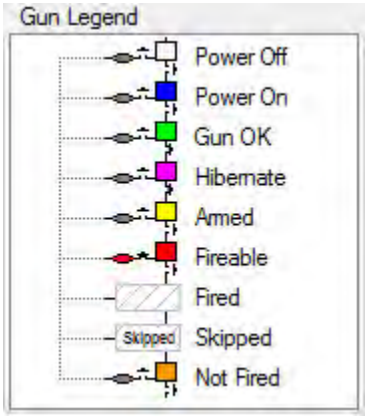
Enable Fire - The **Enable Fire** button commands starts the following sequences:

1. The V/I plot appears and immediately starts recording wire line current and voltage. This is used for shot detection.
2. The selected switch connects its detonator to the wire line 4 seconds later in time. The operator must apply (50-60)V onto the wireline before the 4 seconds expire. The reason for this action is to guarantee that the switch string is sufficiently powered when the detonator connects.

Switch Skip – The **Switch Skip** button provides a method to skip over malfunctioned guns. A switch skip command skips the bottom most detected gun in a string. Each additional switch skip command initiated propagates upward one gun.

Abort – The abort button stops the current operation.

Gun Legend – This legend indicates the state of the switch in the string.



Power Off – No power/communication to switch
Power On – Power applied to switch
Gun OK – Switch verified and operational
Hibernate – Switch is OFF and W/L Switch is ON
Armed – Switch is ready for detonator connection
Fireable – Switch is armed and ready for power to be applied to detonator/igniter
Fired – Enable Fire function has been performed
Skipped – Switch has been skipped and unable to be armed
Not Fired – Enable fire function has been performed but switch remains functional

Perf Unit Setup – Returns the user to the setup screen.

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5.3.1 Gun Check

A Gun Check is initiated by selecting the Gun Check button on the Gun Control Screen. The screen shown in Figure 24 results from a successful gun check.

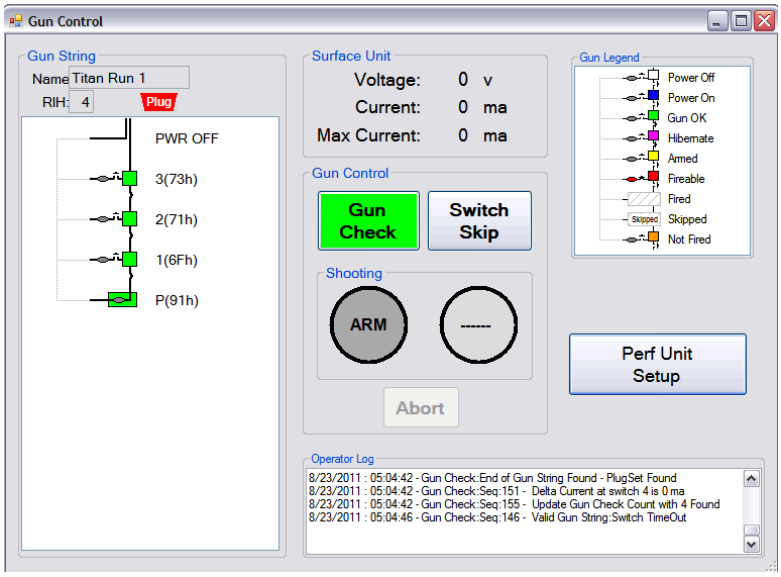

Figure 24

The following indicate a valid gun check:

1. All switch icons are green in color
2. Operator Log does not indicate any errors.

Shown in Figure 25 is the result of an invalid gun check. For this example the wire line was not connected between switch (6Fh) and switch (71h).

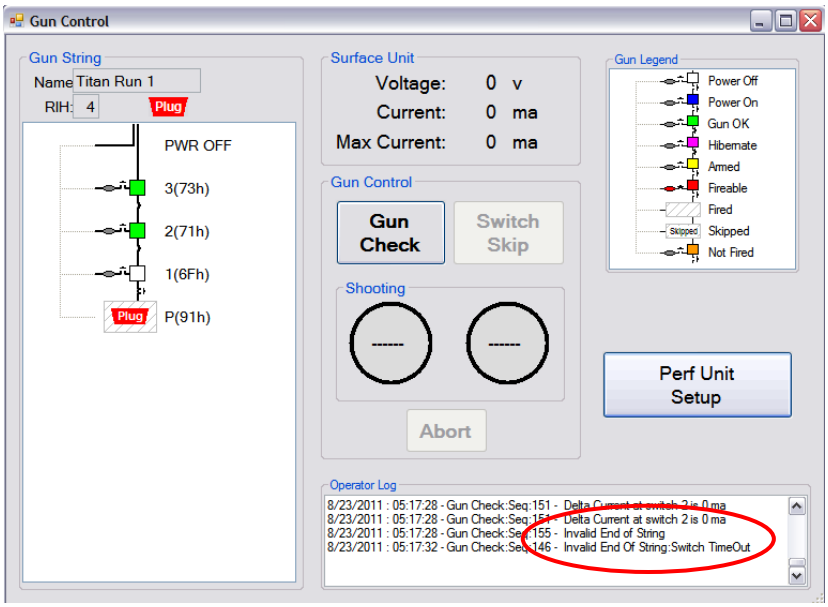

Figure 25

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The following would indicate an invalid gun check:

1. Switch icons below the detected error are NOT green in color
2. Operator Log will indicate errors. Circled in RED above.

5.3.2 Arm and Fire Sequence

Note: Before arming a gun, verify that the depth correlation and tie-in on the perforating correlation software and/or company procedures have been followed.

The **ARM** button becomes active follows a successful gun check, see Figure 24. The results of selecting an active **Arm** button are shown in Figure 26.

1. The Icon for the gun to be fired turns Yellow.
2. The Arm Button changes to Yellow in color with the word “Armed”.
3. A 15 second countdown timer becomes visible indicating the time remaining to select the **Enable Fire** button.

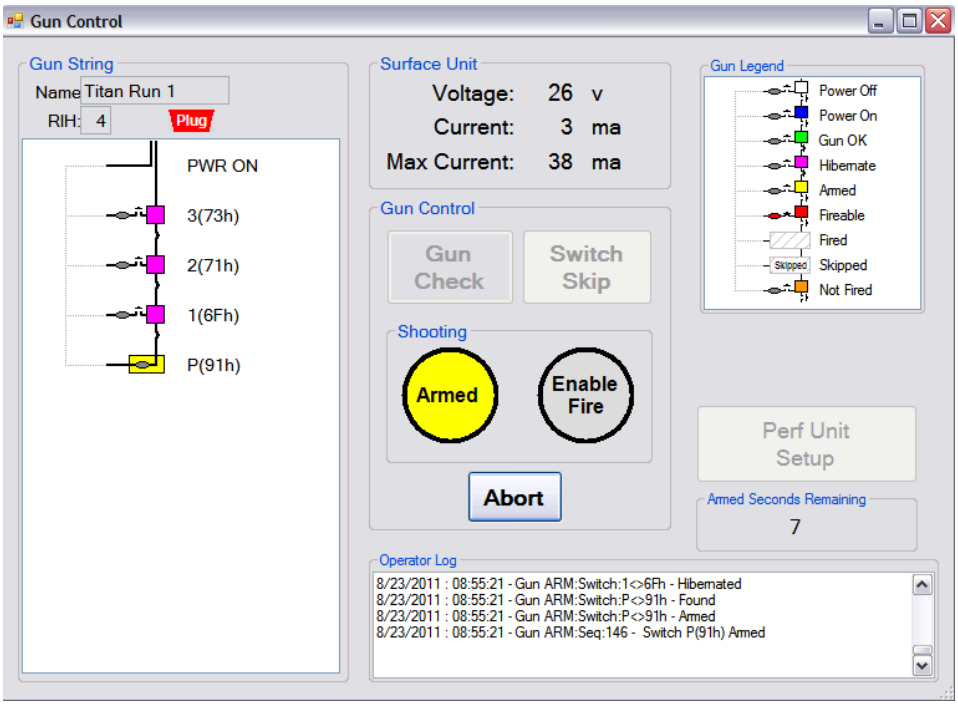

Figure 26

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By selecting the **Enable Fire** button in Figure 26, the following results occur as indicated in Figure 27:

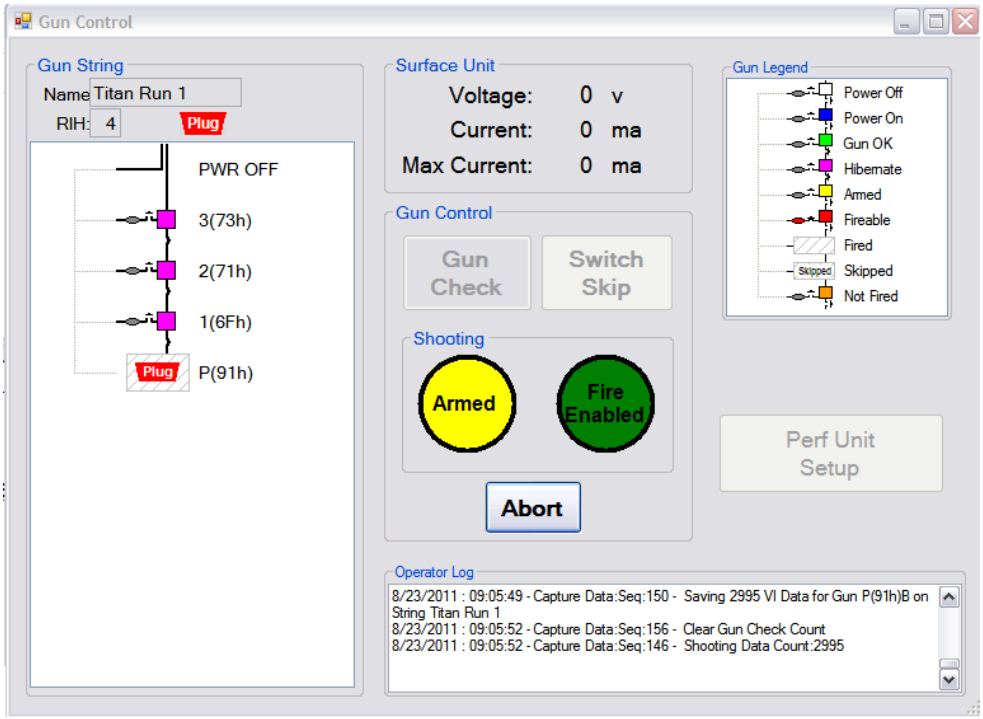

Figure 27

1. The Icon for the gun to be fired changes to a crosshatch image.
2. The Enable Fire button changes to Green in color with the words “Fired Enabled”.
3. A V/I shot plot appears.

The Shooting Power Supply voltage should be ramped to (50-60) volts immediately after the the **Fire Enabled** button turns Green. At the end of the first 4 second time period, as seen on the shot plot, the Perf Switch connects the detonator to the wire line. Following the 4 second time period, turn the Shooting Power Supply to a sufficient voltage to fire the specific detonator. Shown in Figure 28 is a typical wire line voltage profile is along with the deto connecting to the wire line at 4 seconds.

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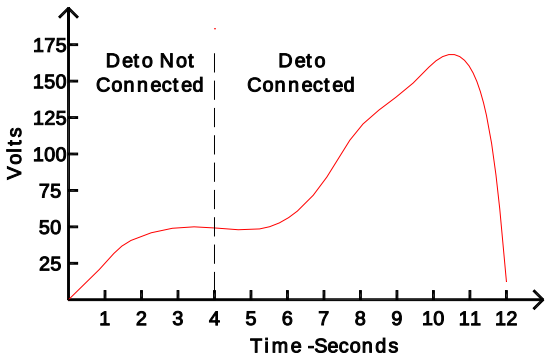

Figure 28

An actual real time VI graph is shown in Figure 29 and produces a voltage and current plot of the applied shooting power and provides a visual aid for shot detection.

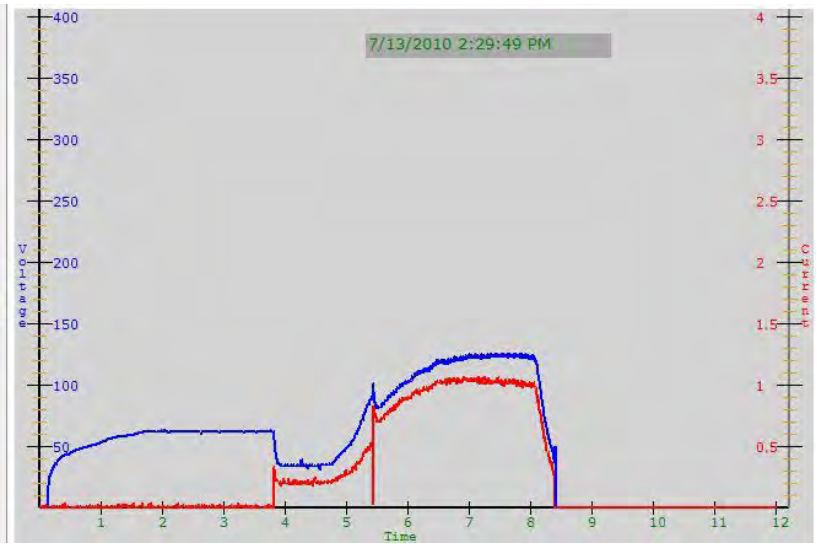

Figure 29

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5.4 Gun Skipping Operations

The ControlFire® system allows the user to skip over misfired guns in order to continue perforating operations with the remaining good gun(s). Gun skip operations can be done from two screens:

1. Gun Control Window
2. Verify Gun String

5.4.1 Gun Skip using Switch Skip button in Gun Control Window

Guns may be skipped directly from the Gun Control window for active switches in the following situations:

1. The device connected to a switch in the firing sequence is no longer needed for the operation. An example would be to skip a switch in a plug setting operations because the switch remains intact after the plug setting operation is complete.
2. A detonator misfires and the switch remains in communication.

Each time the **Switch Skip** button is selected, the bottom most active switch will be skipped. Once the **Switch Skip** operation is completed the gun string icons will indicate the skipped guns. Shown in Figure 30 is a gun string with a skipped Plug and a skipped bottom gun.

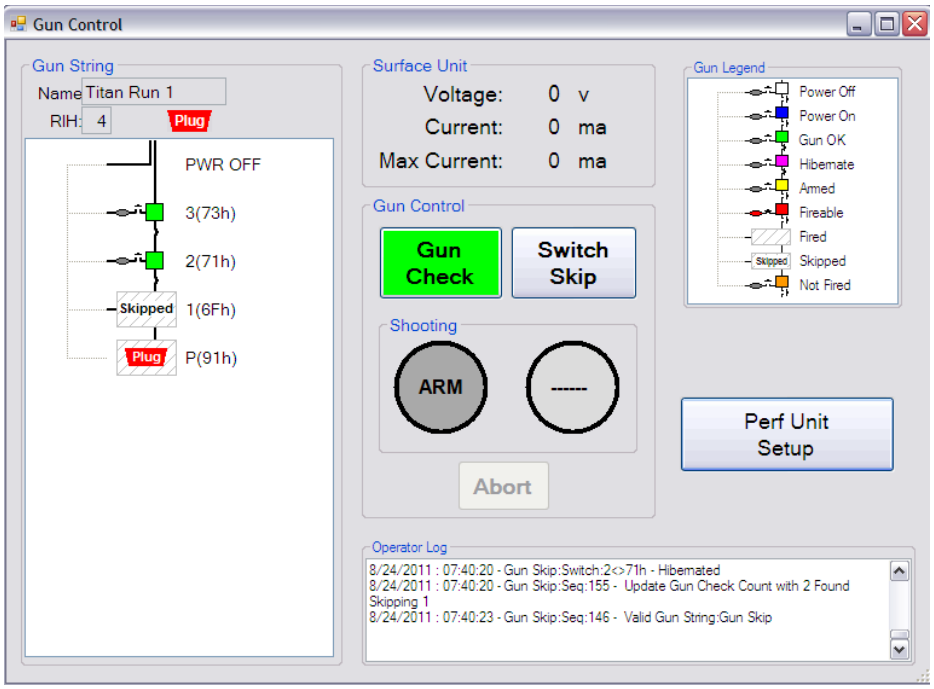

Figure 30

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5.4.2 Gun Skip using Verify Gun String Window

In the event that communication of a ControlFire® Switch is lost in the middle of the gun string, it will be necessary to initiate the Gun Skip using the **Verify Gun String** button on the Set Up screen in Figure 22. This event could be cause by broken wires, shorted wires, loss of ground, bad feed-through and etc.

The result of a Gun Check with a disconnected switch is shown in Figure 31 as an example (No communication below switch 2(71)). In this case the **Switch Skip** is not active and in order skip the Plug and Gun 1 the Verify Gun String screen must be used.

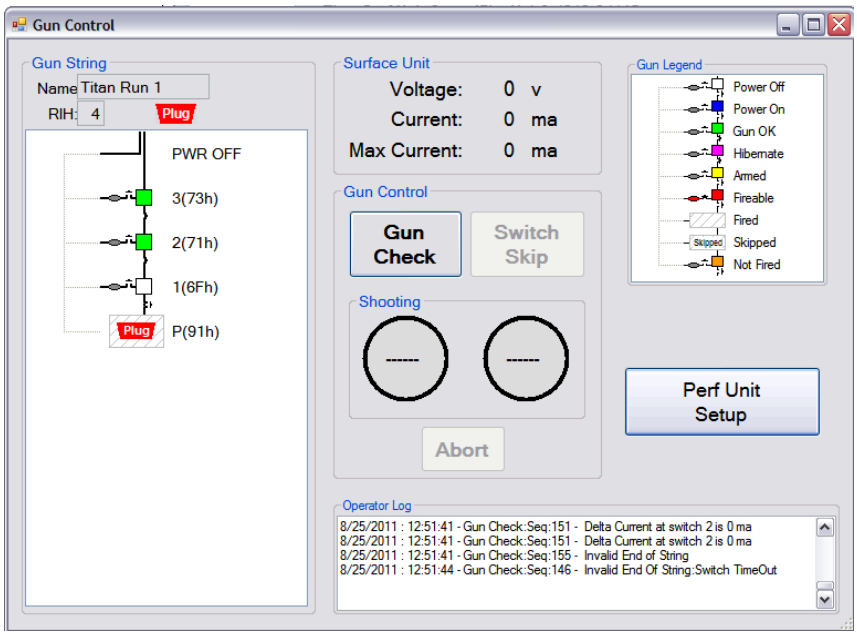

Figure 31

The following steps will allow skipping of the Plug and Gun 1 in order to fire the top 2 guns:

1. Return to the Perf Unit Setup screen. (Select **Perf Unit Setup** button on the Gun Control screen)
2. From the Perf Unit Setup screen, select the **Verify Gun String** button. The results of this action is seen in Figure 32.

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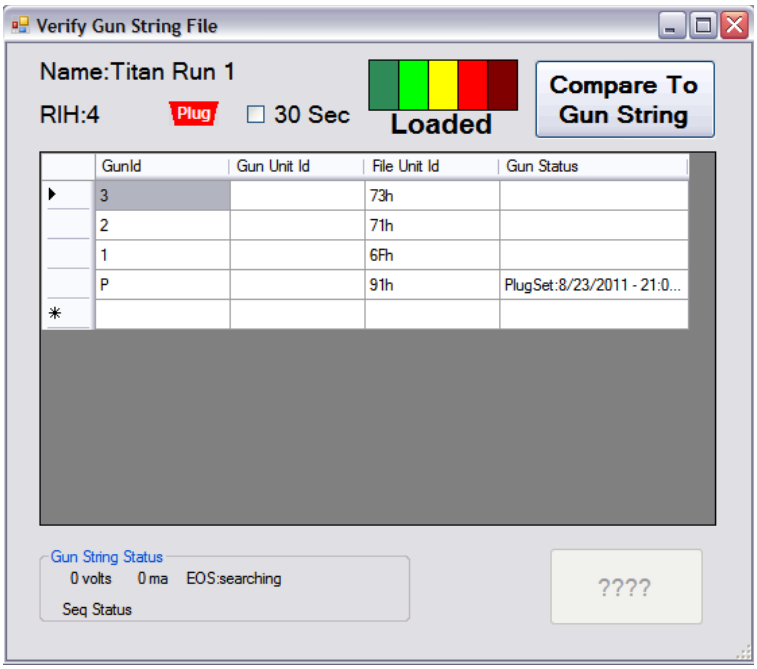

Figure 32

3. Before skipping guns, a Compare to Gun String should be done to validate the failure. Select the **Compare to Gun String** button and the results are shown Figure 33. As seen in Figure 33, this operation confirms the same condition as found on the Gun Control Screen.

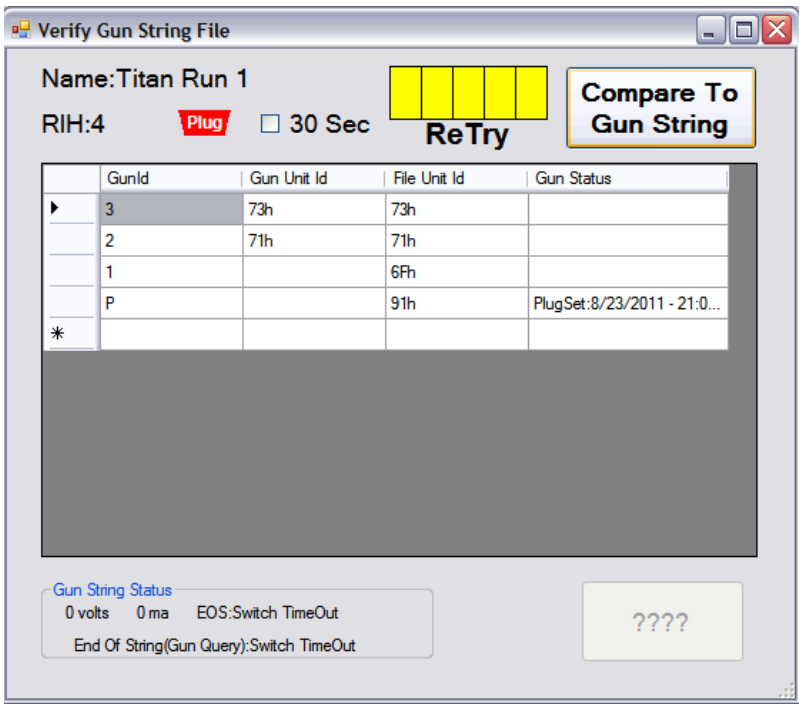

Figure 33

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4. The skip operation is accomplished for each gun by right clicking in the Gun Status column and the row of the gun to be skipped. This action opens a dropdown window. Select Gun Skip from the dropdown. For this example both the Plug and Gun 1 were skipped. The result is seen in Figure 34.

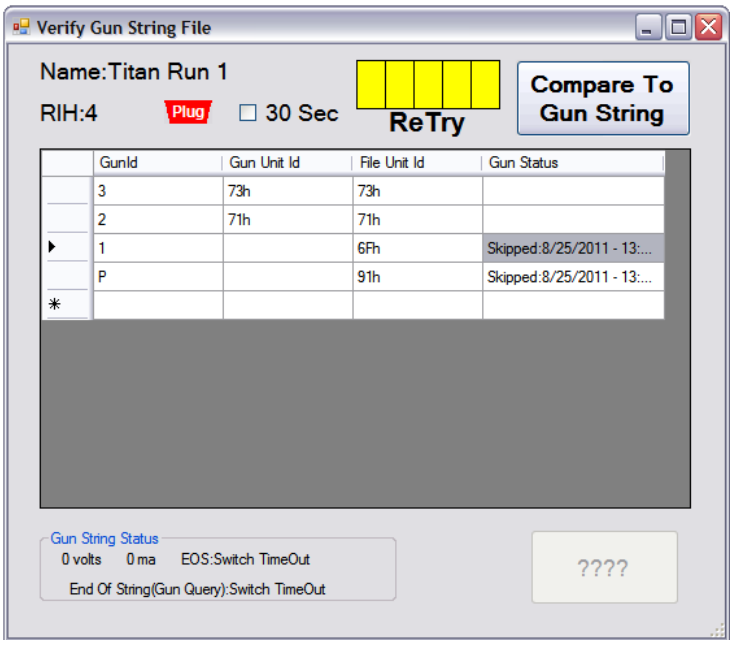

Figure 34

5. Verify the Gun String by selecting the **Compare to Gun String** button. The result of this action is seen on Figure 35. The Gun String is again verified.

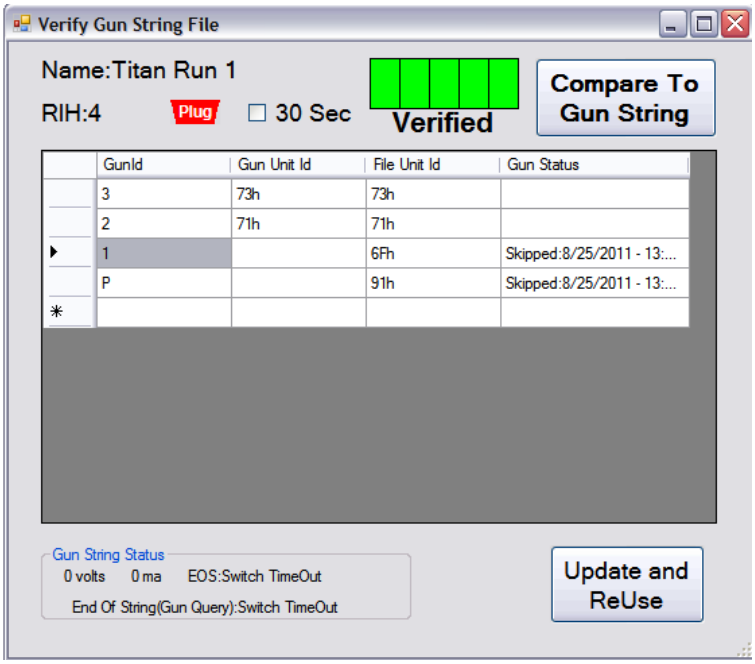

Figure 35

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6. Select the **Update and Re-Use** button to return to the Setup screen.
7. From the Setup screen select the Gun Control button to return focus back to the Gun Control screen.
8. Shown in Figure 36 is the result of a successful Gun Check after performing a gun skip on the Plug and Gun 1. The remaining gun string can now be used.

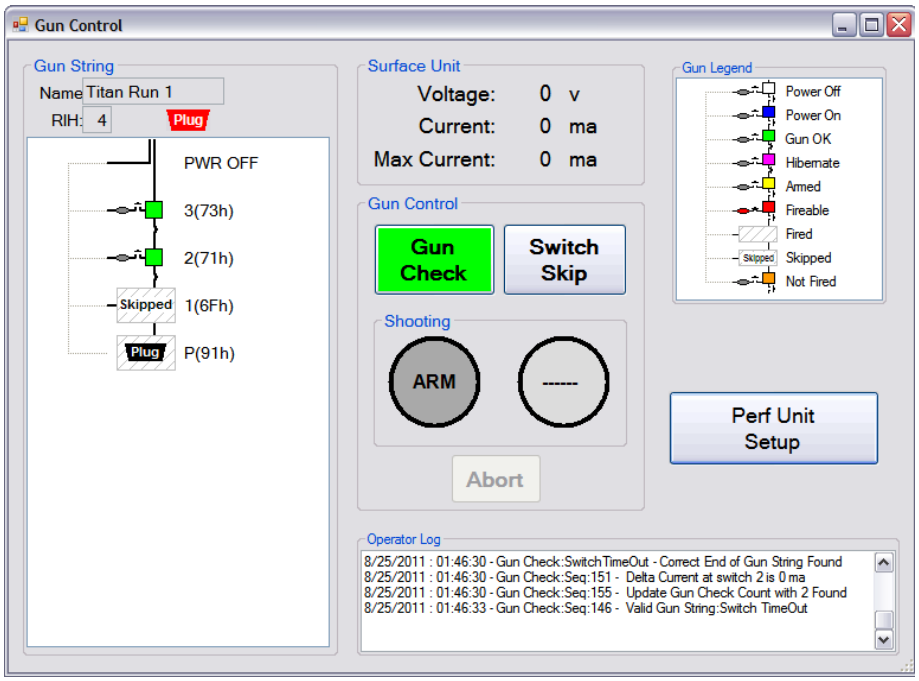

Figure 36

6.0 Cleaning Instructions

There are no user serviceable parts inside the box and the unit does not require any preventive maintenance.

If the unit requires service it must be returned to Hunting Titan Ltd.

The unit may be cleaned using a damp cloth to remove and dust and dirt form the case and the metallic faceplate on the inside.

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7.0 VeriFire®

The panel shown in Figure 37 is a VeriFire® ControlFire® Switch Tester. The purpose of the VeriFire® panel is to test and confirm the proper operation of ControlFire® switches contained in an armed or unarmed perforating gun while on surface. This unit is self-contained and equipped with a rechargeable battery, built-in touch keys and a sunlight visible LCD. A USB input is also available that supports saving new gun string files and comparing gun strings to existing stored files. It is highly recommended to check the gun string after gun loading, after gun arming and before running in hole using the VeriFire® panel (PN: 9002-013-210). Refer to the *VeriFire® User Manual* for instructions and safe use.

Figure 37

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8.0 Gun Loading Instructions

The following procedures are recommendations from Hunting Titan on proper gun loading techniques when implementing ControlFire® switches into perforating gun systems. Only personnel properly trained in ControlFire® operations and explosives handling should load perforating guns containing ControlFire® switches. Refer to API RP 67 Latest Edition for safe practices and standards which must be followed when loading perforating guns.

- **Through Wire Installation:** Run a live wire down the length of the charge tube body as shown in Figure 38. Secure the wire throughout the length of the charge tube body preferably with Teflon tubing (PN: E2500-TTI-S14-1100-NAT) or electrical tape as shown in Figure 39. The ends of the wires should be configured through the openings at each end of the charge tube as shown in Figure 40.

Figure 38

Figure 39

Figure 40

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- **Inserting Charge Tube into Gun:** Insert charge tube into gun housing as shown in Figure 41.

Figure 41

- **Connecting Top Sub to Gun:** Connect the live wire coming from the top of the gun to the feed through wire coming from the live pin of the top sub. Attach top sub to gun. Be careful not to pinch wires.

- **Building a Tandem Sub:** It is recommended to use tandem subs with ground screw taps when possible. The tandem sub should contain an EBFire® gland to fit the EBFire® Feed-Through (PN: 9400-EBTW). Install the EBFire® Feed-Through into the tandem sub. Make sure that the EBFire® Feed-Through sits flush with the bottom of the gland fitting. Install retainer nut (PN: 9400-EBRN-250) into the tandem sub body.

- **Grounding:** ControlFire's electronic communication is bi-directional and requires a better ground than conventional switch systems. Below is a list of grounding techniques in order of most effective to least effective.

    1. Ground to ground wire screw tapped into the sub.
    2. Ground to BOTH a ground wire coming from the above charge tube and a grounding spring in the up-hole end of the sub

       (When grounding to the charge tube, a secondary ground such as a grounding spring is highly recommended).
    3. Use a retainer nut with ground (PN: 9400-EBRN-WG) for the tandem sub and run a ground wire along the length of the charge tube with the live wire to the sub below. Must use EBFire Feed-Through with ground (PN: 9400-EBTW-WG) in tandem sub.

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*****The following procedure is the recommended practice when guns are to be armed through the port of the tandem sub. When not arming through the tandem sub port, the ControlFire® switch and detonator must be connected before attaching the tandem sub to gun *****

- **Connecting Tandem Sub to Gun Above:** Feed the detonating cord, live wire and ground wire(s) from the bottom of the gun above through the tandem sub body and out the port of the tandem sub. Attach the tandem sub to the bottom of the gun as shown in Figure 42. Be careful not to pinch wires.

Figure 42

- **Connecting Tandem Sub to Gun Below:** Connect the live wire from the top end of the gun below to the pin on the 9400-EBTW installed in the tandem sub (Refer to Appendix A1 for instructions on attaching wire to EBS pin sub). Attach the gun below to the tandem sub. Be careful not to pinch wires.

*****When implementing the RF-Safe ControlFire® system, the ControlFire® switch is connected during arming. Proceed to Section 9.2 "Arming Instructions for the RF-Safe ControlFire® Assembly" if using the RF-Safe ControlFire® System *****

- **Installing ControlFire® Switch into Tandem Sub:** Connect the white wire from the ControlFire® switch body to the live wire coming from the gun above. Connect the ground wire(s) from both the gun above and sub to the black wire coming from the ControlFire® switch body. Connect the blue wire from the ControlFire® switch body to the white wire from the 9400-EBTW installed in the tandem sub. Figure 43 and 44 shows the proper wiring for the ControlFire® switch in a tandem sub. The green and red wires coming from the ControlFire® switch body should be left alone until arming the gun. (Note that the ControlFire® switch body may be black shrink wrap or maroon plastic)

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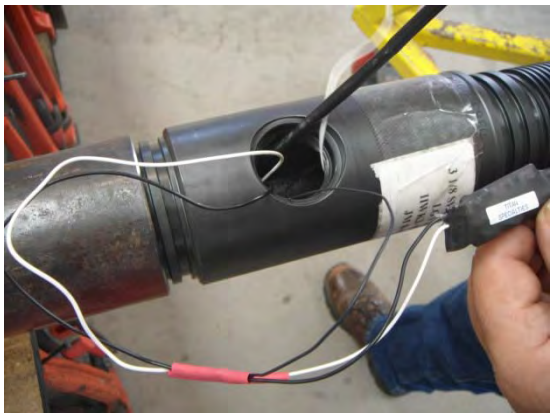

Figure 43

Figure 44

- **Installing ControlFire® Switch into Bottom Gun (No Plug):** Connect the white wire from the ControlFire® switch body to the live wire coming from the bottom gun. Connect the ground wire(s) from the bottom gun to the black wire coming from the ControlFire® switch body. The blue wire coming from the ControlFire® switch body does not connect to anything. The green and red wires coming from the ControlFire® switch body should be left alone until arming the bottom gun.

- **Installing ControlFire® Switch into Bottom Gun (With Plug): FOR PLUG-SHOOT APPLICATIONS, THERE WILL BE TWO ControlFire® SWITCHES BELOW THE BOTTOM GUN: ONE FOR THE BOTTOM GUN AND ONE FOR THE IGNITER TO THE SETTING TOOL.** The additional ControlFire® switch designated for the igniter may be housed in a separate adapter (such as EB tandem sub plus adapter PN: 0365-012-301) between the bottom gun and plug-shoot adapter. Connect the white wire from the ControlFire® switch body to the live wire coming from the bottom gun. Connect the ground wire(s) from the bottom gun to the black wire coming from the ControlFire® switch body. Connect the blue wire coming from the ControlFire® switch body to the white wire coming from the body of the additional ControlFire® switch (Shown circled in red in Figure 45), which is dedicated to the igniter for setting a plug. Ground the black wire coming from the additional ControlFire® switch body to the same ground as that of the ControlFire® switch above or to the ground coming from the adapter below. Figure 45 shows a diagram of the proper wiring for plug-shoot applications.

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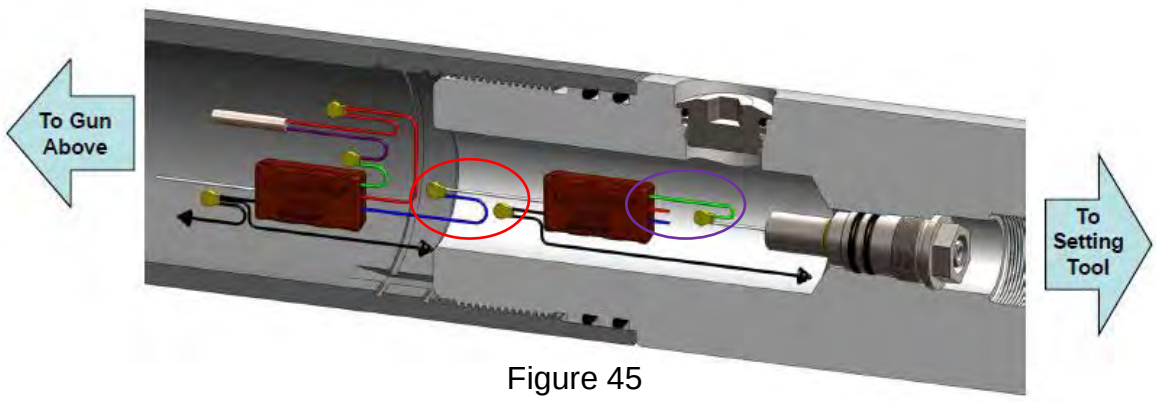

Figure 45

- **Connecting Bottom Gun to Plug-Shoot Adapter:** There must be a bulk head pressure seal between the bottom gun and the firing head of the setting tool. Titan EBFire® plug-shoot adapters provide such a feature. Feed the green wire from the last ControlFire® switch through to port of the plug-shoot adapter. Attach the bottom gun or switch housing sub to the plug-shoot adapter. Be careful not to pinch wires. Connect the green wire from the last ControlFire® switch designated for the igniter to the live through wire which connects the bulk head of the plug-shoot adapter to the setting tool firing head as shown circled in purple in Figure 45. Leave the blue and red wires of the last ControlFire® switch un-terminated as shown circled in purple in Figure 45. **Do not attach setting tool firing head until ready to arm gunstring.**

- **Check Gun String with VeriFire® Panel:** It is highly recommended to check the gun string after gun loading using the VeriFire® panel (PN: 9002-013-210). Refer to the *VeriFire® User Manual* for instructions and safe use.

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9.0 Arming Instructions

The following procedures are recommendations from Hunting Titan on proper gun arming techniques when implementing ControlFire® switches into perforating gun systems. Only personnel properly trained in ControlFire® operations and explosives handling should arm perforating guns containing ControlFire® switches. Refer to API RP 67 Latest Edition for safe practices and standards which must be followed when arming perforating guns. Table 2 gives the compatible detonators and igniters which can be used to arm perforating guns containing ControlFire® switches.

Normally, it is recommended that the cable head be attached to the gunstring before arming the top gun. However, if an additional standard ControlFire switch (without a detonator attached) is in line above the first armed ControlFire® switch, then all guns in the gunstring may be electrically and ballistically armed before attaching the gunstring to the wireline pending the approval of the operator in charge (Refer to API RP-67).

*****The following procedure is the recommended practice when arming guns through the port of the tandem sub. When not arming through the tandem sub port, the ControlFire® switch and detonator must be connected before attaching the tandem sub to gun *****

9.1 Arming Instructions (Non RF-Safe ControlFire® System)

- **Arming Gun Through Tandem Sub:** Secure detonator body into an approved explosives safety tube. It is recommended to always check the detonator resistance using an approved explosives safety multimeter when applicable. Connect the appropriate detonator wire to the red wire of the ControlFire® switch body. Connect appropriate wire of the detonator to the green wire of the ControlFire® switch body. Remove detonator body from the explosives safety tube. Attach detonator to detonating cord coming from the above gun. Be careful not to pinch wires when securing arming ports.

- **Arming Bottom Gun (No Plug):** Follow the same arming procedures from “Arming gun through a tandem sub” above. Be careful not to pinch wires when securing bottom sub.

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- **Arming Bottom Gun (With Plug): THERE SHOULD BE TWO ControlFire® SWITCHES BELOW THE BOTTOM GUN: ONE FOR THE BOTTOM GUN AND ONE FOR THE IGNITER TO THE SETTING TOOL.** Secure detonator body into an approved explosives safety tube. It is recommended to always check the detonator resistance using an approved explosives safety multimeter when applicable. Connect the appropriate detonator wire to the red wire of the ControlFire® switch which is directly attached to the bottom gun. Connect the appropriate wire of the detonator to the green wire of the ControlFire® switch which is directly attached to the bottom gun. Remove detonator body from the explosives safety tube. Attach detonator to detonating cord coming from the above gun. The green wire from the additional ControlFire® switch (no detonator attached) should be connected to the live through wire which connects the bulk head of the adapter to the setting tool firing head as shown in Figure 45. Leave the blue and red wires of the last ControlFire® switch un-terminated as shown circled in purple in Figure 45. Attach the setting tool firing head which contains a compatible igniter.

- **Check Gun String with VeriFire® Panel:** It is highly recommended to check the gun string after gun arming using the VeriFire® panel (PN: 9002-013-210). Refer to the *VeriFire® User Manual* for instructions and safe use.

9.2 Arming Instructions for the RF-Safe ControlFire® Assembly

Users of the RF-Safe ControlFire® assembly (PN: DETO-CFA-T) should read the "User Safety and Responsibility" document, which is shipped with each package, prior to using the assembly. It is recommended to always check the detonator resistance using an approved explosives safety multimeter before arming.

*****The following procedure is the recommended practice when arming guns through the ports of the tandem subs. When not arming through the tandem sub port, the RF-Safe ControlFire® assembly must be connected before attaching the tandem sub to gun *****

For RF-Safe ControlFire® assemblies which include larger detonators such as the A-85 (PN: DETO-CFA-A85-T), a window sub (PN: 0365-000-569A) or a larger borehole sub (PN: 0365-000-366 placed below the EB tandem sub or PN: 0365-000-569A alone) should be used as the tandem sub.

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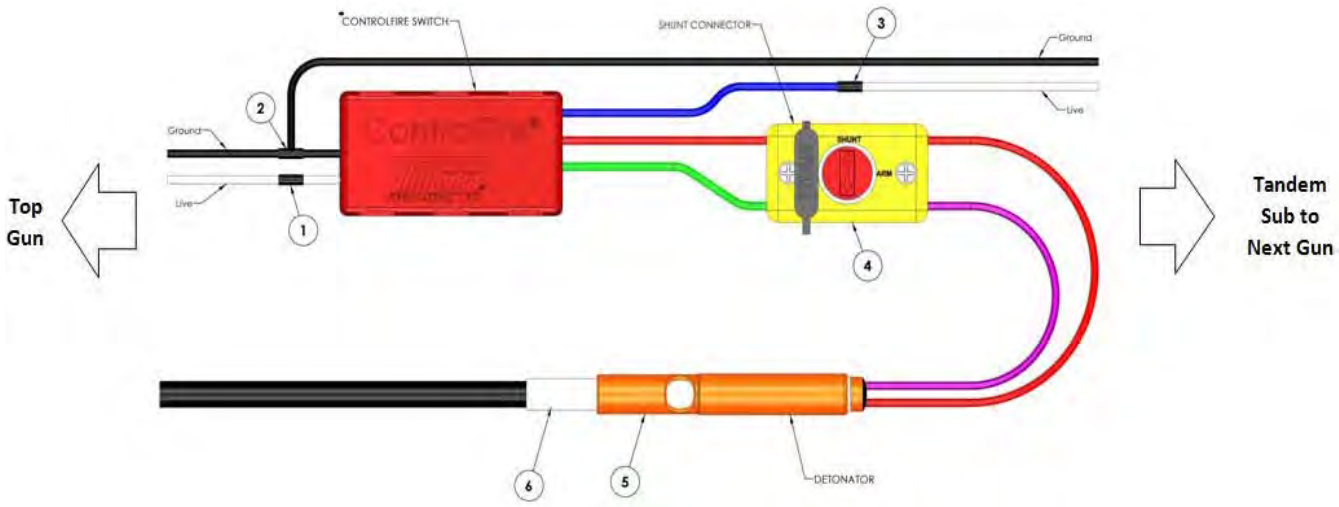

Figure 46

- **Arming Gun Through Tandem Sub: Refer to Steps in Figure 46**

1. Connect the live wire from the gun above to the white wire of the RF-Safe ControlFire® assembly.
2. Connect the ground wires from both the gun above and the tandem sub to the black wire of the RF-Safe ControlFire® assembly.
3. Connect the live wire from the tandem sub to the blue wire of the RF-Safe ControlFire® assembly.
4. With the detonator secured in an explosives safety tube, turn the dial of the shunt connector from the “SHUNT” to the “ARM” position.
5. Remove the detonator from the explosives safety tube.
6. Connect the detonator to the detonating cord coming from the top gun.

   Be careful not to pinch wires when securing arming ports.

- **Arming Bottom Gun (No Plug): Refer to Steps in Figure 46**

Arm the bottom gun using the same steps in the “Arming Gun Through Tandem Sub” section above with the following changes for Steps 2 and 3:

2. Connect the ground wire from the bottom gun to the black wire of the RF-Safe ControlFire® assembly.
3. The blue wire of the RF-Safe ControlFire® assembly is not connected to anything and may be left un-terminated.

   Be careful not to pinch wires when attaching bottom sub.

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- **Arming Bottom Gun (With Plug): Refer to Steps in Figure 46**

  For plug-shoot applications, a standard ControlFire® switch (no detonator attached) must be added to the bottom RF-Safe ControlFire® assembly for the igniter of the setting tool. The additional ControlFire® switch designated for the igniter may be housed in a separate adapter (such as EB tandem sub plus adapter PN: 0365-012-301) between the bottom gun and plug-shoot adapter. Use a compatible igniter for the firing head to the setting tool.

  Arm the bottom gun using the same steps in the "Arming Gun Through Tandem Sub" section above with the following changes for Steps 2 and 3:

  2. Connect the ground wire from the bottom gun to the black wire of the RF-Safe ControlFire® assembly.

  3. The blue wire coming from the RF-Safe ControlFire® assembly will be connected as follows:
     Connect the white wire of an additional ControlFire® switch (no detonator attached) to the blue wire of the RF-Safe ControlFire® assembly coming from the bottom gun. Ground the black wire coming from the additional ControlFire® switch body to the same ground as that of the RF-Safe ControlFire® assembly above or to the ground coming from the adapter below. Connect the green wire from the additional ControlFire® switch (no detonator attached) to the live through wire which connects the bulk head of the adapter to the setting tool firing head. Leave the blue and red wires of the last ControlFire® switch un-terminated.

     Attach the setting tool firing head which contains a compatible igniter. Be careful not to pinch wires.

- **Check Gun String with VeriFire® Panel:** It is highly recommended to check the gun string after gun arming using the VeriFire® panel (PN: 9002-013-210). Refer to the *VeriFire® User Manual* for instructions and safe use.

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10.0 ControlFire® Part Numbers

Description	Part Number
ControlFire® Switch System	
V1.8 ControlFire® Switch	9002-013-120-1.8
Command and Control Panel (portable)	9002-013-510
Command and Control Panel (rack mount)	9002-013-550
VeriFire Panel	9002-013-210
Wireline Switch Simulator Panel	9002-013-610
Panel External Test Block	9002-013-320
Cable Kit	9002-013-017
EBFire® Feed Thru	9400-EBTW
EBFire® Feed Thru w/ Ground	9400-EBTW-WG
Retainer Nut – ¼" ID	9400-EBRN-250
Retainer Nut – ¼" ID w/ Ground	9400-EBRN-WG
RF-Safe ControlFire® System (with Austin Powder detonator selection)	
RF-Safe Switch with A-85 Detonator	DETO-CFA-A85-T
RF-Safe Switch with A-96L Detonator	DETO-CFA-A96L-T
RF-Safe Switch with A-105 Detonator	DETO-CFA-A105-T
RF-Safe Switch with A-105-100 Detonator	DETO-CFA-A105100-T
RF-Safe Switch with A-140 Detonator	DETO-CFA-A140-T
RF-Safe Switch with A- 140F Detonator	DETO-CFA-A140F-T
RF-Safe Switch with A- 140S Detonator	DETO-CFA-A140S-T
Shooting Power Supply	
ControlFire Shooting Power Supply (SPS)	9002-013-810-1

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11.0 User Agreement

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Appendix

A1. EBS Down Hole Pin Wire Attachment

Place a length (1/2” or longer) of white silicone tubing (9400-EBWST) on wire to be attached to switch pin

Strip ¾” insulation off wire

Start with wire at 90 degrees to downhole pin

Place bare wire in the groove at end of pin, with the end of the insulation touching the pin.

Wrap bare wire around groove in pin one full turn, crossing standing end (the long body) of wire away from the switch body. (downhole side)

Rotate wire 90 degrees such that the long insulated body of the wire is pointing straight downhole and the short bare wire is lying along the length of the pin, pointing at the switch body. Make sure that the bare wire is not long enough to reach the body of the switch and cause a short circuit.

Slide a length (1/2” or longer) of white silicone tubing (9400-EBWST) over the pin and wire, pinning the short bare wire down to the pin.

Done properly, this knot gives the smallest possible profile and is very reliable. Pulled to breaking, it typically breaks below the tie point

A touch of grease on the tubing will help the retainer slide over the tubing if needed

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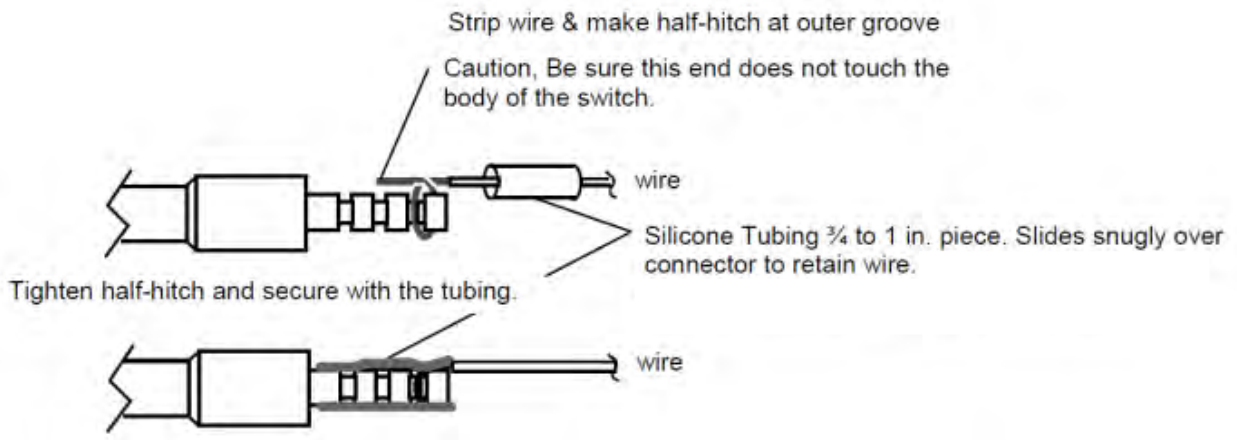
Strip wire & make half-hitch at outer groove
Caution, Be sure this end does not touch the body of the switch.
wire
Silicone Tubing ¾ to 1 in. piece. Slides snugly over connector to retain wire.
Tighten half-hitch and secure with the tubing.
wire

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